DOCUMENT RESUME

ED 358 730 FL 021 297

AUTHOR Kaneko, Yasuo
TITLE Parsing as a Process of Applying I-Language Modules: A Case Study Based on the Processing of Quantifier Float Constructions in Japanese.
PUB DATE 93
NOTE 22p.; For the complete volume, see FL 021 293.
PUB TYPE Reports - Research/Technical (143) -- Journal Articles (080)
JOURNAL CIT MITA Working Papers in Psycholinguistics; v3 p55-74 1993

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Case Studies; *Grammar; *Japanese; *Language Processing; Native Speakers; *Sentence Structure; Structural Analysis (Linguistics)
IDENTIFIERS *Parsing; *Quantifier Float Constructions (Linguistics)

ABSTRACT

The goal of this study is to understand the ways in which humans apply relevant modules of knowledge of language to an input sentence in a parsing process. To this end, quantifier float constructions in Japanese are analyzed, as a case study, on the basis of the view that the output in parsing comprises discrete and multiple categories. Then, a framework for analysis is provided with two relevant modules of knowledge of language in which the output or judgements of a given sentence by native speakers could be classified into categories. Finally, on the basis of an analysis of the main features of the output, the problem of ways that the process of applying the relevant modules of knowledge of language is organized. Although the paper discusses a constraint on the phenomenon of quantifier float constructions in Japanese in relation to problems of parsing, this does not mean that a performance-based explanation replaces traditional, grammar-based notions. The problems of parsing that are addressed are only concerned with the process in which knowledge represented by the grammar-based notions is applied and with outputs from the process. (VWL)

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Parsing as a Process of Applying I- Language Modules: A case of Study Based in the Processing of Quantifier Float Constructions in Japanese.

Yasuo Kaneko
Kushiro Public University of Economics

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FL 018 974

MITAWPP 3 (1993) 55-74

Parsing as a process of applying I-language modules: A case study based on the processing of quantifier float constructions in Japanese•

Yasuo Kaneko
Kushiro Public University of Economics

1. Introduction.

The goal of this study is to understand the ways in which humans apply relevant modules of knowledge of language to an input sentence in a parsing process. To this end, we will analyze quantifier float constructions in Japanese, as a case study, on the basis of the view that the output in parsing comprises discrete and multiple categories. Then we will provide a framework for analysis with two relevant modules of knowledge of language in which the output or judgements of a given sentence by native speakers could be classified into the categories. Finally, on the basis of an analysis of the main features of the output, we will consider the problem of the ways in which the process of applying the relevant modules of knowledge of language is organized.

Although the present paper will discuss a constraint on the phenomenon of quantifier float constructions in Japanese in relation to problems of parsing, this does not mean that a performance-based explanation replaces traditional, grammar-based explanations of the constraint. What substitutes for the notions which play an important role in the traditional explanations of the constraint are also grammar-based notions. The problems of parsing which we will address are only concerned both with the process in which knowledge represented by the grammar-based notions is applied and with outputs from the process.

1.1. Problems

Generally speaking, parsing can be defined as a process which receives a PF as an input and creates a corresponding LF (or more) as an output. We could define parsing in this way very easily (Figure 1).

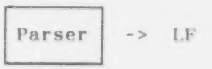


Figure 1. A definition of parsing

The ease of defining it, however, does not warrant any easy solution of problems which we face when we try to understand the detailed processes of parsing in humans. There seems to be no

agreement even as to the overall structure of a human parser. It seems to me that this situation requires us to go back to and to reconsider original issues of the so-called parsing problem.

I think that the parsing problem is both

(I) an analogous problem to Plato's problem in language acquisition, and at the same time,
(II) an inverse problem of Descartes' problem in language production.

By "an analogous problem to Plato's problem" I mean that a sentence does not contain enough information in itself to allow us to interpret it fully. Thus the poverty of stimulus in sentence interpretation, which is due to partial realization of information conveyed by an expression, parallels the poverty of stimulus in language acquisition. To put it another way, a parser cannot create an LF solely on the basis of a PF; (s)he must contain a rich set of knowledge of language to apply to an input sentence.

By "an inverse problem of Descartes' problem" I mean that the human sentence parsing process faces a problem of unpredictability of any aspects of an input sentence, which is caused by the creativity in language production.

Therefore, in order to understand the human sentence parsing process, we need to answer the following two questions.

(I') How do humans apply a rich set of knowledge of language to an input sentence and recover the information which is omitted at the time of encoding of an expression or lost during the transmission ?
(II') How do humans cope with the unpredictability of any aspects of an input sentence, which is caused by the creativity in language production ?

Correspondingly, a theory of the human sentence parsing process must consist of two aspects:

(I'') an aspect which concerns itself with the process of applying a rich set of knowledge of language to an input sentence, and
(II'') another aspect which concerns itself with those mechanisms and procedures which make it possible for humans to cope with the unpredictability of any aspects of an input sentence.

I think that we can realize the first aspect of the theory of the human sentence parsing process as an idea that parsing is a process of applying the knowledge contained in the modules of the I-language (Chomsky 1986) to an input sentence. The principle-based parsing (e.g., Berwick, 1991; Johnson, 1989; Wehri, 1988) is an attempt to realize this idea. Although, in fact, this paradigm contains a variety of approaches (cf. Berwick, et al., 1991), straightforward and comprehensive attempts to realize the idea are made in Fong (1991), where, for now, they explore computational possibilities of control structures which apply relevant modules of knowledge of language

to an input sentence on the basis of logical dependencies among the modules. However, what matters in psycholinguistic studies is not just the computational possibilities but empirical facts about the process of applying the modules to an input sentence. We do not know anything about the latter.

On the other hand, the second aspect of the theory, that is, the aspect concerning the parser's flexibility when (s)he must cope with the unpredictability of an input sentence, clearly has to do with the following various kinds of mechanisms and procedures which give the parser the flexibility. These include a look-ahead buffer which holds unstructured items to delay syntactic decisions (Marcus, 1980), a method of underspecification which is intended to avoid unnecessary commitment to positing nodes which lack evidence for the existence at the time of expanding X bar rules (Marcus, Hindle, & Fleck, 1983; Barton & Berwick, 1985), a race model which computes possible structures in parallel and discards unnecessary structures immediately (Frazier & Fodor, 1978; McRoy & Hirst, 1990), error recovery procedures such as backtracking and more intelligent ones, to mention just a few. However, it is safe to say that the way in which this second aspect of the theory can be realized seems to be still globally unclear, witness the controversies such as delayed use (e.g., Frazier, 1990) vs. immediate use (e.g., Tanenhaus & Carlson, 1989) of argument structure information.

In the present paper I will focus on the first aspect of the parser. How can we provide a more constrained picture of parsing as a process of applying the I-language modules ? I will address this problem in the next section.

1.2. The nature of output in the human sentence parsing process: A possible source of constraint

A possible constraint on the structure of the process of applying the I-language modules might come from the following observations:

"So-called "ungrammatical" or "deviant" sentences are often quite readily parsable and even perfectly intelligible." (Chomsky 1991, p.19)
"Sentences like what do you wonder who likes or John is proud Bill, though hard to understand, don't cause people to collapse like a rule-based system would." (Berwick, 1991, p.117)

In other words, any sentence can receive some interpretation. Therefore, the dichotomy between grammatical sentences and ungrammatical ones no longer holds. This simple statement implies a very profound change of view of the nature of parsing in general and of the nature of output in particular, because this negation of the dichotomy discards altogether both the traditional view of language as a set of sentences which are well-formed linear strings of words and the traditional view of a parser basically as an automaton which accepts the string as well-formed or rejects it as ill-formed (Chomsky 1990).

The goal of this study is to understand what kind of organization of the process of applying the I-language modules

could produce the output with the observed nature in parsing. To this end, my point here is to take up as serious subjects both the view of parsing as a process of applying the I-language modules and the view of the nature of the output in parsing and to examine what this change of view of the nature of the output implies on the basis of a concrete phenomenon of the so-called quantifier float constructions in Japanese. First, let me remind you here of the phenomenon.

2. Quantifier float constructions in Japanese.

In the following pairs of sentences, which roughly mean the same thing, the (b) forms of them are called quantifier float constructions.

(1)a. San-nin-no gakusei-ga ik-i-mas-i-ta.
3 people GEN student NOM go POLITE PAST
("Three students went.")
b. Gakusei-ga san-nin ik-i-mas-i-ta.
(2)a. San-nin-no gakusei-o ik-ase-mas-i-ta.
ACC CAUSATIVE
("(Someone) made three students go.")
b. Gakusei-o san-nin ik-ase-mas-i-ta.
(3)a. San-nin-no gakusei-ni shukudai-o das-i-mas-i-ta.
DAT homework give
("(Someone) gave homework to three students.")
b.?Gakusei-ni san-nin shukudai-o das-i-mas-i-ta.
("(Someone) gave homework to three students." or
"Three people gave homework to students.")

Phrases like "san-nin" in the (b) forms are called floating numeral quantifiers (henceforth abbreviated as FNQ).

Some linguists describe the correspondence between these pairs of sentences in terms of movement. However, in this study, we shall limit our attention to an aspect of this phenomenon that there is a correspondence between the (a) forms and (b) forms in some cases but not in others. Then we shall consider what kind of constraints must be there in order for the (b) forms to make sense (cf. Miyagawa 1989).

As these examples show, there seems to be some constraints on this correspondence. Incidentally, in terms of movement, we can say that some constraints exist on the possibility of "launching" or "floating" a numeral quantifier from a noun phrase (henceforth, NP) which the quantifier originally modifies. Then what are the constraints like ? The studies which have been done so far have tried to characterize or define the constraints in terms of some linguistic concepts such as the following. Let me give you a very brief review of the studies. First, a constraint was characterized or defined in terms of grammatical relations such as subject and object; that is, quantifiers can be floated from subject NPs and direct object NPs but not from other oblique NPs (Okutsu 1969; Kamio 1977).

After that, the constraint was redefined in terms of surface cases such as nominative and accusative, because some other examples show that NPs which are subject and at the same

time dative cannot launch quantifiers;

(4)a. San-nin-no gakusei-ni shukudai-ga konas-e-mas-i-ta.
SUBJECT NP DAT do POSSIBLE
("Three students managed to finish homework.")
b.?Gakusei-ni san-nin shukudai-ga konas-e-mas-i-ta.

That is, quantifiers can be floated from nominative NPs and accusative NPs but not from other oblique NPs (Shibatani 1977).

Recently, definitions of the constraint became more complicated, accomodating concepts such as the obligatory nature of a modified NP as an argument with respect to a predicate, the distance between an FNQ and a modified NP, the kind of an intervening element between an FNQ and a modified NP, and word order (Haig 1980; Shimozaki 1989), although it is also pointed out in Miyagawa (1988; 1989) that the constituent which the FNQ can modify is basically an NP which receives " a thematic role from an external source such as the verb" (1989, p.27).

3. An alternative analysis.

3.1. Two kinds of top-level computations and multiple categories of output

However this line of studies might proceed, it seems to me that they have all overlooked the following point. That is, there is a serious problem in their way of looking at the data on which their arguments are based.

Above all, these studies are, even quite recently (for example, Miyagawa, 1988; 1989), based on data which presuppose a rather rigid dichotomy between grammatical sentences and ungrammatical ones. However, as has been well-known since the early days of generative grammar, there is much heterogeneity among the judgements made by native speakers on a given sentence (cf. for example, Shibatani 1982).

Moreover, there are some attempts to introduce such concepts as a degree of acceptability into the data (for an explicit introduction of the concept of degree, see Shimozaki, 1989). However, the mere introduction of the degree concept will not suffice. In this kind of study, it is implicitly assumed both that the number of categories of the output in parsing is only one and that the degree of acceptability is the difference within that one and the same category. However, this assumption would not hold a priori.

As a solution to these problems, there is an alternative way of looking at the data. As we will see later in more detail, we can make certain discrete distinctions in the data. The distinctions are different from both the dichotomy and the degree of acceptability. They are presumed to correspond to the output of parsing in humans. I would like to propose that we should base studies of quantifier float constructions on the data which reflect these distinctions.

More specifically, this alternative framework for analysis claims the following points. First of all, (i) the number of categories of output in parsing is plural. Second, (ii) each category of the output corresponds to a combination in which some

principles or factors involved in the processing of quantifier float constructions are violated and others are not. A maximally well-formed sentence is represented as a combination in which none of the principles involved are violated. Thus, this alternative analysis claims that there are as many cases in which quantifier floating is impossible as combinations in which the principles involved are violated. Finally, (iii) a difference in the degree of grammaticality or acceptability, if any, is within each of the categories of the output.

Then how can we realize this alternative framework for analysis ? First of all, we can say that primacy of such factors as grammatical relations and surface cases in the process of interpreting the quantifier float constructions seems doubtful. Rather, I would like to propose that two factors, the possibility of theta-role assignment and the possibility of establishing modification relation from an FNQ to a modified NP, play primary roles in the process involved. Now let me explain involvement of these two factors in the process briefly.

3.1.1. Theta-role assignment

One of these factors is the possibility of assigning a theta-role to an FNQ in a sentence. For example, in sentence (1-b), the verb can assign the same agent-role to the FNQ and the nominative NP. In the more interesting case of sentence (3-b), the verb can assign, on the one hand, an agent-role to the FNQ; however, it assigns, on the other hand, a goal-role to the dative NP. Thus, in this case, the FNQ and the dative NP which the FNQ is originally intended to modify receive different theta-roles.

(5)a. 200 kg.-no rikishi-ga dohyo-ni aga-t-ta.
Sumo wrestler Sumo ring mount PAST
("A Sumo wrestler who weighs 200 kg. mounted the Sumo ring.")
b.*Rikishi-ga 200 kg. dohyo-ni aga-t-ta. (Otsu 1988)

In sentence (5-b), the FNQ, "200 kg.", cannot receive any theta-role from the verb. In marked contrast to examples (1-b) and (3-b). This situation, which makes sentence (5-b) "ungrammatical", constitutes another category of output from the processing of quantifier float constructions.

A note on the relation of this analysis to the theta-theory would be in order here. This analysis apparently seems to violate the theta-theory because the FNQ that is not an argument receives a theta-role. Even if the FNQ could have an argument status, the analysis violates the theta-criterion anyway because one and the same theta-role is then assigned to the two arguments.

However, we could avoid this violation by positing something like the theta-role transmission principle proposed by Jaeggli (1981) (the following explanation is cited from Dorr, 1991). The theta-role transmission principle is represented as follows;

(6) [CL + Case i + Theta j]...[NP + Case i] =>
[CL + Case i + Theta j]...[NP + Case i + Theta j].

where "CL" stands for a pronominal clitic.

(7) Le regalé un libro a Juan.
Cl. gave a book to John
(" I gave a book to John.")

In sentence (7), "Le" is ["le" + accusative + patient] and "a Juan" is ["a Juan" + dative]. So, "a Juan" does not yet have a theta-role. Moreover, it cannot receive a theta-role directly from the verb without violating the theta-criterion, because the theta-role which it can receive is the same as the theta-role already assigned to the pronominal clitic, "Le". However, through this principle it can receive a theta-role without the theta-criterion violation.

By analogy, we could propose something like:

(8) [NP + Case i + Theta j + feature k]...[FNQ + feature k] =>
[NP + Case i + Theta j + feature k]...[FNQ + Theta j + feature k].

where "FNQ" stands for the floating numeral quantifier and "feature" stands for some semantic features discussed below.

3.1.2. Modification

Another factor is the possibility of establishing modification relation from an FNQ to a modified NP. Here the term "modification" is used "as a general term for relations such as qualification of and quantification over", following Sportiche (1988, p.429) and Ueda (1990, pp.86-87). For example, in sentence (1-b), the FNQ, "san-nin", can be easily interpreted or judged to be able to modify the preceding NP. In sentence (3-b), the FNQ, "san-nin", is not easily interpreted to be able to modify the preceding NP. This situation contributes to the "unacceptability" of this sentence. Note that it does not always follow that this combination of a dative NP and a FNQ contributes to "unacceptability";

(9)a. San-nin-no gakusei-ni it-te-mora-t-ta.
3 people GEN student DAT go want PAST
("(Someone) wanted three students to go."
b. Gakusei-ni san-nin it-te-mora-t-ta.

When we interpret the FNQ in the context of this sentence, the same combination does not necessarily lead to "unacceptability" but to a partitive interpretation.

3.1.3. Output

Taking into account these two factors, we can propose the following structure of "what is being computed", in Marr's (1982) sense, and of what is output in the process of interpreting the quantifier float constructions. First, there are two kinds of computations on the top-level (Figure 2).

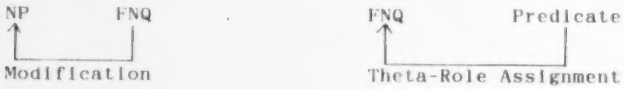


Figure 2. Two kinds of computations on the top-level: modification and theta-role assignment. These schemata represent only two constituents involved and order them according to the word order of the Japanese language.

These two kinds of computations on the top-level determine the overall pattern and major features of the output in parsing.

Second, modification and theta-role assignment have the same structure of alternatives (Figure 3); first, both divide into "possible" and "impossible", and in the case of "possible", both divide into "equal" and "not equal to". Incidentally, "not equal to" in the "possible" case of modification means a so-called partitive interpretation.

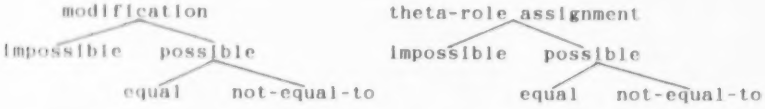


Figure 3. The structure of alternatives in modification and theta-role assignment.

These things are summarized in Table 1.

Table 1. Contents of computation and output.

modification		theta-role assignment		output
possibility	identity	possibility	identity	
possible	equal	possible	equal	(1)well-formed
possible	equal	possible	not-equal-to	(2)different theta-roles
possible	equal	impossible	irrelevant	(3)nonexistent
possible	not-equal-to	possible	equal	(4)partitive interpretation
possible	not-equal-to	possible	not-equal-to	(5)different theta-roles
possible	not-equal-to	impossible	irrelevant	(6)nonexistent
impossible	irrelevant	possible	equal	(7)nonmodifiable
impossible	irrelevant	possible	not-equal-to	(8)different theta-roles
impossible	irrelevant	impossible	irrelevant	(9)impossibility of theta-role assignment

Needless to say, more subtle distinctions in the output can be made, for example, on the basis of the fact that there is a case in which we find it impossible to assign any theta-role to an FNQ in the context of a sentence at a first-pass analysis, but we find it possible, in turn, at a second-pass analysis. However, possibilities like this are not pursued here, and thus distinctions based on the possibilities are not incorporated into the analysis proposed here.

An example of the output (9) in Table 1 is the sentence (5-b). The main feature of this sentence consists of the fact that it is impossible to assign any theta-role to the FNQ and that the FNQ remains without a theta-role.

(10) Gyuuniku-ga 200 kg. ur-e-mas-i-ta. (Otsu 1988)
beef sell passive
("A 200 kg. of beef was sold.")

In contrast to this, sentence (10), which contains the same FNQ as the sentence (5-b), is maximally well-formed and therefore falls under the type of output (1) in Table 1. In this case, first, the FNQ can modify the preceding NP because "gyuuniku" is a mass noun and "kg" is a suitable unit for a mass noun. Second, the predicate "sell" can assign a theme-role to the FNQ. We can explain a similar sentence (11) (Kamio, 1977) in the same way.

(11) *Kuruma-o 2000 cc kau.
car buy
("(Someone) buys a 2000 cc of car.")

In this case, the FNQ cannot modify the preceding NP because a suitable unit for counting cars is "dai", not "cc". However, the predicate "buy" can assign a theme-role to the FNQ under the interpretation that the theme has the function of a mass noun. This theme-role is the same as the theta-role which is assigned to the accusative NP "kuruma". Thus the sentence (11) falls under the type of output (7) in Table 1.

The sentence (3-b) is an example of output (8) in Table 1 if the modification is judged to be impossible as is usually the case, where "Gakusei-ni" has a goal-role and "san-nin" has an agent-role. If the modification is judged to be possible in this sentence, then the output of the same (3-b) falls into output (2) or (5) in Table 1, depending on the judgement of equality.

3.2. Subfactors affecting the top-level computations

It seems possible that these two factors of theta-role assignment and modification are also affected by some other minor factors, apart from structural positions, although it might become clear that these subfactors must be recast in structural terms (cf. references in (iv), for example). First, the factors which might affect judgement of the possibility of modification from an FNQ to a modified NP are as follows:

(1) whether or not an auxiliary number or a numeral classifier

(for details, see e.g., Denny, 1979), which constitues a quantifier with a numeral, is a suitable unit for counting objects which a set denoted by a modified NP includes or for measuring a property which a modified NP has. For examle, "kg" in sentence (5-b) is not a suitable unit for humans.
(ii) whether or not [NP + postpositional particle + FNQ] is read as a single intonational constituent.
(iii) what kind of predicate constitutes a context for interpretation. For example, although the FNQ in sentence (4-b) is not usually judged to be able to modify the preceding NP, the one in sentence (9-b) can be judged to be able to modify the preceding NP. This might mean that the possibility of modification from an FNQ to a preceding NP depends on the context for interpretation, which is provided by the predicate.
(iv) kind of intervening constituents (Sportiche, 1988; Ueda, 1990).
(v) distance (Shimozaki, 1989).
(vi) whether or not the FNQ is a focus of new information (Katagiri, 1991; 1992).
(vii) whether or not a modified NP agrees in number with the FNQ (Okutsu, 1986).

Second, one of the factors which might affect judgement of the possibility and identity of theta-role assignment is:

(i) whether or not the semantic features which a theta-role requires are consistent with the semantic features of FNQ.

(12)a. San-nin das-u.
three-people give PRESENT
("Three people give (something).")
b. San-dai das-u.
three-problem PRESENT
("(Someone) gives three problems (to someone).")

In sentence fragment (12-a), the FNQ, "San-nin", has a semantic feature, [+animate], which is consistent with one of the semantic features that an agent-role has. Thus this feature makes it possible to interpret the FNQ as playing an agent-role in this fragment. In contrast to this, the FNQ, "San-dai", in sentence fragment (12-b) has a semantic featutre, [-animate], which makes it impossible to interpret the FNQ like the one in (12-a).
It might also be possible that these factors are in turn affected by certain subfactors. For example, the factor of whether or not the FNQ is a focus of new information, which affects the possibility of modification, is affected by the following subfactors (Katagiri 1991; 1992).

(i) whether or not there is a contrasting form.
(13) Hanako-wa bounenkai-ni hutatsu shinnenkai-ni mittsu i-t-ta.
year-end party 2 New Year's party 3
("Hanako went to two year-end parties and three New Year's parties.")
(ii) whether or not there ia an emphatic particle "mo".
(14) Hanako-wa kotoshi party-ni mittsu-mo i-t-ta.

this year EMPHATIC
("Hanako went to three parties this year.")

(iii)whether a clause represent a result (15-a) or a state (15-b).

(15)a.Kodomo-ga geragerato hutari wara-t-ta.
children loudly laugh
("Two children laughed loudly.")
b.Kodomo-ga geragerato hutari wara-t-te-i-ta.
("Two children were laughing loudly.")

Another factor, whether or not the FNQ agrees in number with the modified NP, which affects the possibility of the modification, is further affected by the following subfactors.

(i) whether or not there is a discrepancy between implicit singularity of a common noun in Japanese and the plurality of FNQ (Okutsu, 1986).

(16) Gakusei-ga tegami-o suu-nin ka-i-ta.
letter several write
("Several students wrote a letter.")

(17) Gakusei-ga koogi-o suu-nin sabo-t-ta.
class cut
("Several students cut the class.")

The relative awkwardness of sentence (16), compared with that of sentence (17), may be attributed to subfactor (i).

(ii) Whether or not there is a discrepancy between the singularity of a proper noun and the plurality of FNQ.

(18) Taro-ga tegami-o suu-nin kaita.

(19) "Sato"-ga 8-nin "Suzuki"-ga 5-nin kono gakko-ni-wa
this school LOC TOPIC
i-mas-u.
there are
("There are eight "Sato" and five "Suzuki" in this school.")

The awkwardness of sentence (18), compared with the naturalness of sentence (19), may be attributed to subfactor (ii).

Returning to the structure of what is computed in processing quantifier float constructions, how can we give concrete computational substance to the proposed structure of the two computations on the top-level? In the next section, we will address this problem.

3.3. Subcomputations of modification and theta-role assignment.

In this section, we will first consider the computation of modification relation from an FNQ to a modified NP and then the computation of theta-role assignment from the predicate to the FNQ.

3.3.1. Modification

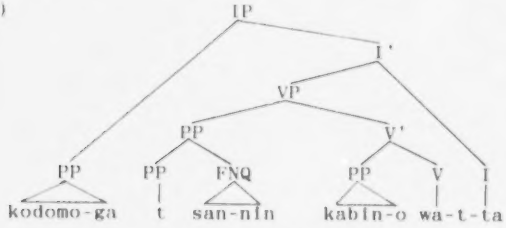
Here, we will define the computation of the possibility of modification relation from the FNQ to the modified NP in terms of the notion of c-command:

(i) to judge whether the FNQ can modify the PP if the FNQ c-commands a PP or the trace of a PP.

Here, let me demonstrate this by considering very simple sentences. In computing the c-command relation, we will assume the Japanese phrase structure according to Ueda (1990) with some minor modifications. For example, in sentence (20), we assume a structure like (21), where the FNQ c-commands the trace of PP; therefore, we are led to judge that the FNQ can modify the NP.

(20) Kodomo-ga san-nin kabin-o wa-t-ta.
children NOM 3 people vase ACC break PAST
("Three children broke a vase.")

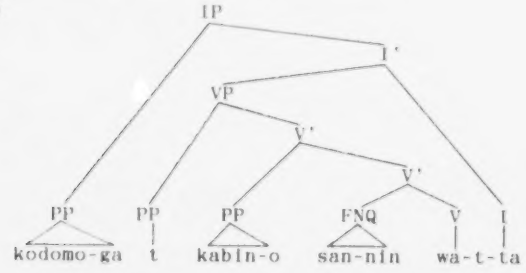
(21)



On the other hand, in sentence (22), we assume a structure like (23), where the FNQ does not c-command the trace of PP "kodomo-ga", therefore, we are led to judge that the FNQ cannot modify the NP.

(22)*Kodomo-ga kabin-o san-nin watta.

(23)



Ueda(1990) explains the ungrammaticality of sentence (22) in the following way. First, "kodomo-ga" and "san-nin" form a single constituent and have the structure (24) at the D-structure.

(24) [np [np kodomo-ga] san-nin]

Second, "kodomo-ga" moves obligatorily from the VP-internal subject position to the specifier position of IP. Third, although "kabin-o" must move by scrambling, "adjunction to VP by scrambling is prohibited" (p.97). Therefore, sentence (22) is

ungrammatical.

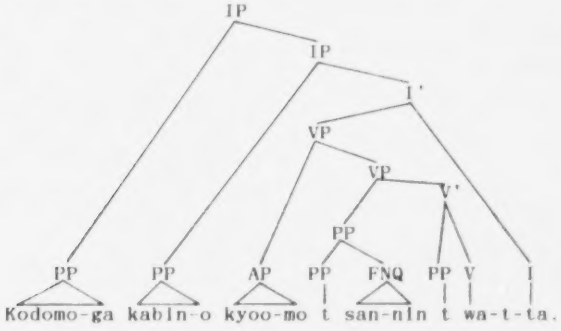
Although the analysis of Ueda (1990) can explain the ungrammaticality of (22), the impossibility of the modification from the FNQ to the NP in the sentence (22) remains to be explained. Because the structure (24) always exists at the D-structure, the modification relation should also hold in spite of the ungrammaticality. However, the modification relation does not hold. Therefore, there must be something which makes the modification impossible other than the violation due to the prohibited adjunction to VP.

The revision which is proposed here assumes (I) that a structure like (24) does not always exist at the D-structure and (II) that a structure like (24) is posited only if there is evidence for movement by scrambling. For example, consider the sentence (25).

(25) Kodomo-ga kabin-o kyoo-mo san-nin wa-t-ta.
today also
("Three children broke the vase also today.")

In this case, "san-nin" is more often judged to modify "kodomo-ga" in contrast to (22). The revised analysis assumes that there is evidence for the movement by scrambling in this sentence because "kodomo-ga" and "kabin-o" appears in higher positions than "kyoo-mo" which is originally in a higher position than the other constituents at the D-structure.

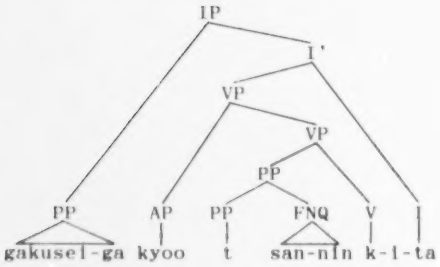
(26)



The same kind of analysis holds for sentence (27), the structure of which is shown in (28).

(27) Gakusei-ga kyoo san-nin k-i-ta.
student NOM today 3 people come PAST
("Today three students came.")

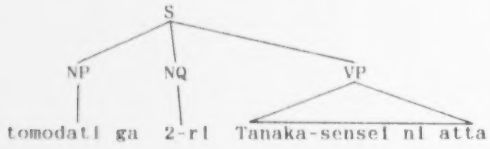
(28)



This definition of the computation of the possibility of modification relation in terms of c-command relation is not entirely new. Miyagawa (1988; 1989) introduced the mutual c-command requirement for establishing the modification relation, which Miyagawa (1988; 1989) regarded as "predication", between an FNQ and a modified NP. Miyagawa's (1988; 1989) argument is as follows. First, the necessity for introducing the c-command condition is shown in the following pairs of sentences and structures (Miyagawa, 1989, pp.28-29).

(29)a. Tomodati ga 2-ri Tanaka-sensei ni atta.
friends NOM 2-CL Prof. Tanaka DAT met
("Two friends met Prof. Tanaka.")
b.*Tomodati ga Tanaka-sensei ni 2-ri atta.

(30)a.



b.

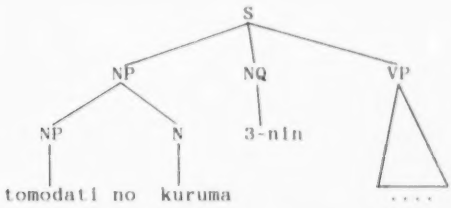
In (29a), the modification is possible and this fact is captured in (30a) by the structural condition that the FNQ c-commands the modified NP because the first branching node, S, dominating the FNQ also dominates the modified NP. On the other hand, the modification is impossible in (29b) and this fact is captured in (30b) by the structural condition that the FNQ does not c-command the modified NP because the first branching node, VP, dominating the FNQ does not dominate the modified NP.

However, Miyagawa (1988; 1989) argues that this c-command condition is not a sufficient condition and introduces the mutual

c-command requirement. According to Miyagawa (1989, pp.29-39), the necessity for introducing the mutual c-command requirement is shown in the following example.

(31) *[NP Tomodati no kuruma] ga 3-nin kosyoosita.
friends GEN car NOM 3-CL broke down

(32)



In sentence (31), the modification is impossible even if the FNQ c-commands the modified NP. Thus only the condition that the FNQ c-commands the modified NP is not a sufficient condition to exclude constructions like sentence (31). In constructions like sentence (29a) where the modification is possible, the FNQ c-commands the modified NP as was seen above, and at the same time the modified NP c-commands the FNQ because the first branching node, S, dominating the NP also dominates the FNQ. On the other hand, in constructions like sentences (29b) and (31) where the modification is impossible, the FNQ does not c-command the NP as in sentence (29b), or the FNQ c-commands the NP but the NP does not c-command the FNQ as in sentence (31).

However, if we could assume that "3-nin" appears under the VP in the structure (32), the mutual c-command requirement is not necessary, because "3-nin" does not then c-command "tomodati" anyway. Moreover, although "3-nin" and "kuruma" c-command mutually under the structure (32), "3-nin" cannot modify "kuruma". Therefore, even the structural requirement alone is not sufficient. Like our framework for analysis, we need to take into account such a factor as whether or not a numeral classifier which constitutes an FNQ with a numeral is a suitable unit for counting or measuring objects denoted by a modified NP.

According to our proposed framework for analysis, there is another factor which we need to take into account. What makes sentence (31) anomalous lies in the fact that it is difficult to have "kosyoosita" assign a theme-role to "3-nin" and "3-nin" remains without a theta-role, at least at a first-pass analysis, because "kosyoo" is usually associated with [- animate] thing.

3.3.2. Theta-role assignment

Next, we will propose a hypothesis of computation of theta-role assignment from the predicate to an FNQ, which consists of the following four steps:

(i) to retrieve the argument structure of the predicate.
(ii) to check whether or not the semantic features of FNQ can satisfy a theta-role provided by the argument structure. If

possible,
(iii)to check whether or not postposition or case markers do not govern the FNQ and whether or not the predicate governs the FNQ.
(iv) to judge whether the predicate can assign a theta-role to the FNQ if postposition or case markers do not govern the FNQ and the predicate governs the FNQ.

It is assumed here that this procedure functions as a default mechanism in the case where there is no argument to which a theta-role of the argument structure of the predicate can be assigned. When there is an argument to which a theta-role can be assigned, something like the theta-role transmission principle replaces the procedure.

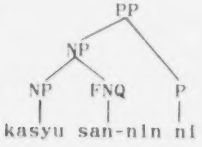
3.3.3. Quantifier shift constructions: Evidence

A partial support of the computational processes of the modification and the theta-role assignment comes from a fact that there is no problem for the modification and the theta-role assignment in the output from an interpretation process of the so-called "quantifier shift constructions" (Shibatani 1977), in which FNQ appears in between a modified NP and postposition. Compare the quantifier float constructions ((b) sentences) and the "quantifier shift constructions" ((c) sentences) in the following set of sentences (Otsu 1988).

(33)a. San-nin-no kasyu-ni puropoozu s-i-mas-i-ta.
3 people GEN singer DAT propose do PAST
("(Someone) proposed to three singers.")
b.*Kasyu-ni san-nin puropoozu s-i-mas-i-ta.
c. Kasyu-san-nin-ni puropoozu s-i-mas-i-ta.
(34)a. San-nin-no kasyu-kara sain-wo mora-i-mas-i-ta.
ABLATIVE autograph get
("(Someone) got autograph from three singers.")
b.*Kasyu-kara san-nin sain-wo mora-i-mas-i-ta.
c. Kasyu-san-nin-kara sain-wo mora-i-mas-i-ta.
(35)a. San-nin-no kasyu-no-mae-ni tat-i-mas-i-ta.
in front of stand
("(Someone) stood in front of three singers.")
b.*Kasyu-no-mae-ni san-nin tat-i-mas-i-ta.
c. Kasyu-san-nin-no-mae-ni tat-i-mas-i-ta.

In the quantifier shift constructions, it is always possible to establish the modification relation from the FNQ to the NP because the structure is like the following;

(36)



Moreover, it is also always possible to assign the same theta-role both to the FNQ and to the modified NP because the theta-

role which is assigned to the NP 's transferred to the FNQ by something like the theta-role transmission principle in structures like (36).

4. Conclusion.

To summarize, the structure of what is computed in processing quantifier float constructions is rather straightforward. Two factors of possibilities of theta-role assignment to FNQ and of establishing modification relation from FNQ and modified NP play primary roles in the processing. Interaction of these two factors determines nine, not two, categories in output which are shown in Table 1.

Now, by way of conclusion, we would like to discuss some of implications which the analysis proposed here might have for one of the original issues, that is, the question of how the process of applying I-language modules to an input sentence is organized. First, the analysis makes use of natural notions of operations such as modification and theta-role assignment, which are involved anyway in the ordinary processes of sentence comprehension. Moreover, these two operations are generators, as contrasted with filters like Case Filter, Empty Category Principle, and so on. If we could divide the principles into these two categories as Fong (1991) does. Therefore, if our analysis which attempts to characterize or define the constraint on quantifier float constructions in terms of these notions is correct, the analysis might show that what determines major features of output in parsing are generators, not filters.

Second, intuitive contents of major features of output in parsing, which are shown in Table 1, show that the factor of theta-role assignment contributes more to the major features of the output than another factor of modification. Therefore, if this is correct, this difference in the contribution to the major features of the output might also mean something about the organization with respect to these two modules.

As a related question, we would like to consider the nature of the human parser. The task of parsing has been traditionally conceived to be restricted to phrase structure parsing or X bar parsing. However, a reconsideration of one of the original issues might show that the task of parsing is not necessarily restricted to X bar parsing. It includes all the processes which apply other I-language modules of syntactic component of grammar as well as X bar rules. In this conception of parsing, such modules as theta-role assignment play primary roles as seen above. However, this might not necessarily mean that the parser is communication-oriented because what is involved in syntax (e.g., Grimshaw, 1990) and in parsing (Pritchett, 1992) may not be the contents of theta-roles. The exact nature of parsing must be determined in relation to other modules of sentence comprehension and to the nature of the interface between the parser and these other modules.

Finally, we would like to discuss some implications of the analysis for psycholinguistic studies in general. First, this analysis might give a more natural explanation for the problem of acquisition of the constraint on quantifier floating. If we

characterized the constraint in terms of grammatical relations or surface cases and we stated that "subject NPs and direct object NPs can launch quantifiers but other oblique NPs cannot" or "nominative NPs and accusative NPs can launch quantifiers but other oblique NPs cannot", then it seems rather ad hoc to think that the constraint stated in these terms is acquired, represented, and used directly. In contrast to this, the problem of acquisition might disappear if we could adopt the kind of explanation of the constraint which is proposed here, because we then do not use the constraint at all when we process quantifier float constructions. Rather, there might exist only a general process of applying I-language modules, and judgements about quantifier float constructions which reflect the constraint might follow derivatively or "deductively" from the process.

Second, whatever individual differences might appear in interpretation of quantifier float constructions could each be attributed to one category of the output or another on the basis of the structure of what is computed shown in Table 1.

Of course, many problems remain to be solved. First of all, the existence of pattern or of types of output in parsing must be verified. Moreover, the psychological reality of judgements of possibilities of modification and of theta-role assignment must also be verified. However, it seems safe to say at least that this line of studies which has been shown in this paper might also shed some light on the nature of the human sentence parsing process.

• I am grateful to Sandiway Fong, Yoshiyuki Igarashi, Kooichi Miyashita, Yukio Otsu, and Steven Pinker for their criticism, questions, and comments on this study. Still remaining errors and inadequecies are, of course, my own.

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